Motor-speech disorders are impairments of planning and programming of articulatory movements (apraxia) or neuromuscular disorders of the speech apparatus (dysarthria). In adults, they can be caused by stroke, traumatic brain injury, and neurodegenerative conditions such as Parkinson’s disease or fronto-temporal dementias such as Progressive Supranuclear Palsy and Primary Progressive Aphasia.

Motor-speech disorders entail considerable cognitive and social-emotional tolls on patients and caregivers, and may drastically impact patient safety. Approximately 150,000 new incidents are reported yearly, with increasing prevalence.

Evidence-based treatment of motor-speech disorders is complicated by the uniquely human oropharyngeal tract and the “muscular hydrostat” formed by the tongue’s eight intertwined muscles that can lengthen, contract and propel laterally or vertically, and also groove, curl, bunch and flatten. Speech-related lingual movements are performed with speed on the order of milliseconds and precision on the order of millimeters. Because they occur automatically, effortlessly, and mainly inside the oropharyngeal tract, their complexity is invisible and underestimated. Consequently, patients with motor-speech disorders may not appreciate target lingual postures and configurations for speech, and clinicians must guess precise sources of speech errors.

Recent advances in the neuroscience of motor-speech production have indicated multiple promising avenues for interventions in disordered cases. First, real-time imaging of the oropharyngeal tract during speech production with ultrasound or magnetic resonance imaging (MRI) has revealed more of the heretofore-invisible complexity, speed and precision of base-of-tongue movements and pharyngeal valving in neurologically intact individuals, and how these can be disrupted in neurologically impaired individuals. These intra-oral images have also been successfully deployed as biofeedback that allows patients to improve their disordered motor-speech production.

Second, neuro-imaging techniques have enhanced our explorations of the neural substrate for motor-speech production. Tractography has led to the discovery of the crucial role of the left frontal aslant tract, and coupling of electroencephalography (EEG) with functional MRI has confirmed hypotheses about neural oscillations tuned to specific auditory processes and oro-motor executions corresponding to rhythmic rates at phonemic, syllabic and phrasal levels of speech.

Third, research focused upon the rarer non-Alzheimer’s-type dementias, and in particular the class of fronto-temporal dementias (FTD), has led to an increased appreciation of motor-speech decline as the initial “signaling” symptom of disease onset and progression. This has inspired new techniques for more accurate speech-based diagnoses of FTD, and for early clinical interventions to decelerate and/or delay motor-speech decline.

Finally, remarkable technological developments in augmentative and alternative communication (AAC) have drastically improved the nonverbal expressive capacities of patients with severe motor-speech disorders. Most notable are brain-computer interfaces (BCI) that transform EEG-derived brain signals into running text or synthesized speech.

Illustrations of Dr. Postman’s research on motor-speech disorders in her Neuro-Rehabilitation of Language Lab at Saint Louis University shall be shared with the audience, with the intent of enticing audience members to join Dr. Postman in creating an inter-institutional consortium for research on the neuroscience of speech and language.